

W. Decker of Dartmouth College told the Science and Man in the Americas meeting in Mexico City. Decker emphasizes the word "forecasting" as in probabilistic weather forecasting—rather than prediction—"to convey this same sense of useful though uncertain predictions of events which lie in the future."

"No single predictive index appears to be the master key to volcano forecasting," Decker notes. Volcanologists try to combine evidence from past history, geology, seismicity, surface deformation, magnetic and electric phenomena, and geochemistry. With the present state of the art, he says, strict zoning can probably save more lives than prediction.

"However, the situation is not hopeless." Useful though not precise forecasting is currently being practiced at Asama in Japan, at Taal in the Philippines, at Besymianny in Kamchatka, at Kilauea in Hawaii and at a few other volcanoes under continuous observation. "The only master key is better understanding of volcanic processes."

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A paper relating volcano eruptions and earth tides, reported in SCIENCE NEWS last October (10/21/72, p. 261), is published this week in the JOURNAL OF GEOPHYSICAL RESEARCH, along with another paper reporting similar findings by Wayne L. Hamilton of Ohio State University. Hamilton has found that the frequency, intensity and latitude of occurrence of volcanic eruptions vary

systematically within the well-known tide cycles. Eruptions are favored in months in which earth tides are large at the latitude of the volcano. He found that the eruptions of two volcanoes, Pelee and Soufriere, occur when two types of wave forms from the tides nearly synchronized.

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Several volcanologists are pointing

## Desert shrubs called 'the neglected resource'

Their names carry the flavor of the Western desert country: sagebrush, salt-bush, creosote bush, burro sage, mesquite, cholla. Hardy, tough, enduring, these and other shrubs of the arid lands survive difficult conditions through superior adaptability.

Shrubs are the dominant vegetation of arid and semiarid regions, but they are among the most misunderstood, most neglected and least used plant forms in the world. So says Cyrus M. McKell, professor of range science and director of the environment and man program at Utah State University. They are, says McKell, a hidden resource.

Desert shrubs need someone to champion their cause, and McKell has taken on that task. In a paper delivered at the Science and Man in the Americas meeting in Mexico City, he lists six popular misconceptions about shrubs:

- Shrubs are worthless invaders. Shrubs that appear worthless to persons unfamiliar with a region may frequently be useful for grazing and other purposes, he says. "The worth of a so-

to signs of a potentially dangerous major eruption of San Cristobal volcano in Nicaragua. Large-volume, high-temperature fumarolic activity in the crater began in May 1971 after 300 years of dormancy. Studies by Richard Stoiber of Dartmouth show an increase in the ratio of sulfates to chlorine in the volcanic gases, a probable indication of a new eruptive period. □

called invader shrubs can only be determined by an overview of its total ecosystem relationships." Sometimes shrubs make farming possible in areas where nomadism would otherwise be the only agricultural activity.

- Shrubs are generally unpalatable to all livestock except goats. "In reality, a significant proportion of the herbage removed by grazing animals comes from shrubs. . . . Not only is the herbage from shrubs palatable to most animals but it may also be crucial to achieving a balance in the nutrient intake . . . ."

- Large areas of valuable land are occupied by worthless shrubs. This involves relative values, McKell points out. "Existing 'worthless' shrubs might have useful properties that are simply unknown or undeveloped." He mentions the liquid wax from the jojoba (see p. 26), high-protein fodder from *Atriplex*, latex from the guayule, and other species high in fatty acids, protein, essential oils. "Some of these could be very useful as 'crops' for arid lands. Under such conditions, many 'worthless' shrubs would have to be reevaluated!"

- Shrubs are low in feed value. "Shrubs are high in digestible protein, phosphorus and carotene."

- Shrubs are spiny and harsh and are therefore a menace. "Not all shrubs are harsh and spiny." Some species "may look formidable, but the net effect is generally not a deterrent to their use."

- Shrub eradication is an essential and an important step in any range improvement program. This is "the most serious and erroneous misconception." At times complete control of shrubs has been a goal of range management. "To manage arid lands wisely requires that we work positively regarding the various advantages of individual shrub species rather than use a shotgun approach designed at indiscriminate control of shrubs per se."

What are the ways arid-land shrubs are useful to man? McKell is not at a loss for answers. They can be used for livestock and animal feed ("existing use of shrubs for domestic animal feed falls far short of the possible potential"). They can lead to commercial products ("many opportunities"). They

## Are the continents propelled by elastic energy?

A major objection to the geophysical theory of plate tectonics or continental drift, to use its older name, is that there doesn't seem to be a sufficient source of energy in the outer layers of the earth to move such heavy things around.

A possible answer to that objection is provided in the June 25 NATURE PHYSICAL SCIENCE by David Pines and Jacob Shaham of the University of Illinois at Champaign-Urbana. They propose that elastic energy stored in the crust and mantle of the earth is sufficient for the purpose.

The elastic energy is generated by stresses set up as a result of deformations caused by forces acting on the earth. Pines and Shaham figure the stored energy to be about  $10^{32}$  ergs at present. They figure that continental drift and seismic activity each release about  $10^{25}$  ergs per year, or about one ten-millionth of the present reserve.

Pines and Shaham propose a theory whereby such motions as continental drift, earthquakes and polar wandering tend always to reduce the energy stored in this elastic "reservoir." This, they say, explains the westerly direction of polar wandering and the drift of continents toward the equator, both of which are observed.

Pines and Shaham propose an "elastic epoch" dating from a cataclysmic event or series of events a hundred million to a billion years ago. They figure this is the best way to get the distortion and the energy storage since it is difficult to see how it could happen otherwise on an earth that is gradually spinning down. They surmise that such a cataclysm might have been the capture of the moon. They suggest then that scenarios could be devised starting from a particular lithospheric configuration at that time, say a supercontinent, and coming down to the present by energy-dissipating motions.

provide wildlife habitat ("good range improvement should be synonymous with good wildlife habitat improvement—and shrubs are a central concern of both"). They stabilize soil ("soil scientists and engineers . . . have neglected untold opportunities to obtain greater variety in color, shape and form" by using grass instead of shrubs to stabilize slopes and cover denuded ground). They "play a key role" in the function of many ecosystems. And they contribute to aesthetics ("the breeding and improvement of woody ornamental shrubs is one of the most promising undeveloped frontiers of plant science").

"Design with nature is the new philosophy," McKell concludes. "There is no reason why it should be necessary to forego the great advantages available by using shrubs if we can understand both their virtues and limitations and develop appropriate strategies to use them properly." □

## \$30 million allotted for research fellowships

As promised a week earlier, Caspar Weinberger, Secretary of the Department of Health, Education and Welfare, announced this week a \$30 million training program of research training fellowships to begin this fiscal year. The fellowships, for young biomedical scientists, will come in the amount of \$10,000 each.

The Administration's budget had called for eliminating such aid by awarding no new training grants and fellowships but continuing existing ones through 1977. Biomedical scientists had protested the cutback. The new money will come from already budgeted funds which, Weinberger said, "will not be needed to fulfill existing commitments under the old program. As these old commitments, principally to institutions, fade out over the course of the next three years, additional funds will be added, bringing the (fellowship) program to a total of \$90 million."

Most of the new money will go directly to students rather than institutions. □

## Aircraft emissions subject of new guides

The Environmental Protection Agency last week issued new pollution emission standards for the nation's aircraft engines, extending the deadline for first application of the standards to new engines from 1976 to 1979 and proposing a program of retrofitting existing engines to bring them into compliance.

The standards represent a reduction of 60 percent for carbon monoxide,

## Ten Soviet cosmonauts in U.S. for training



Wide World Photos

*Cosmonaut briefings begin: Astronauts greet Leonov (far right) and Kubasov.*

Two years from now, on July 15, 1975, the United States and the Soviet Union will carry out a joint manned space flight. This week a 32-member Soviet delegation, including 10 cosmonauts, arrived at the Johnson Space Center (JSC) in Houston for a two-week session with their American counterparts.

The meetings are the latest in a series of joint management, technical and training sessions that have been in process now for over a year. The last such meeting was in March at JSC. But this session is the first billed as cosmonaut training.

The delegation is headed by Prof. Konstantin D. Bushuyev, the Soviet technical director of the project. (His American counterpart is Glynn S. Lunney of JSC.) The cosmonauts in the delegation include the prime and backup flight crewmen for the mission. The prime crewmen are Aleksey A. Leonov, who performed the first "spacewalk" during the Voskhod 2 mission in 1965, and Valeriy N. Kubasov, who was a crewman of the Soyuz 6 mission.

The Soviets also have selected a prime crew for a second Soyuz spacecraft, which would be launched if something went wrong with the launch of the prime crew and spacecraft. They are cosmonauts Anatoliy V. Filipchenko, who was on Soyuz 7, and Nikolay N. Rukavishnikov, a crewman of Soyuz 10.

American astronauts for the mission are commander Thomas P. Stafford, command module pilot Vance D. Brand, a space rookie, and Donald K. Slayton, one of the original seven Mercury astronauts. Slayton, who has never flown in space, will be the docking module pilot. Backup crewmen are Alan L. Bean, who will command the upcoming Skylab 2 mission, Ronald E. Evans, veteran of Apollo 17, and Jack R. Lousma, also a Skylab 2 crewman.

Members of the Soviet delegation are attending classroom lectures on the basic elements of the Apollo spacecraft, life and support systems, communications systems, the docking module systems and the basic flight-plan time lines. Specific mission training for the cosmonauts is not planned for this visit, although the cosmonauts will probably enter the Apollo flight simulators at the center.

Members of the U.S. flight crew team will visit the Soviet Union this fall for similar instruction on the Soyuz spacecraft. □

70 percent for hydrocarbons and 50 percent for nitrogen oxides from most large commercial jets, beginning in 1979. Stricter standards will be instituted in 1981. Acting EPA Deputy Administrator John R. Quarles Jr. said the three-year extension of the deadlines represented the agency's judgment that longer lead times than previously estimated were necessary for compliance by the aircraft industry.

To help make up for the extra pollution generated by pre-1979 engines, the agency is proposing a program of retrofitting such engines with emission-con-

trol devices as these become technologically feasible. The Air Force and NASA are currently carrying on research projects to develop the necessary technology through contracts with two major manufacturers of gas turbine engines, General Electric and Pratt and Whitney.

In addition to engine emissions standards, EPA announced it was joining with the Department of Transportation in a series of experiments designed to reduce pollution from ground operations of aircraft and auxiliary equipment. □